REMARKS

Claims 15-29 are pending. Claims 15-18 and 23-25 have been rejected under 35 U.S.C. §112, second paragraph. Claims 15-18 and 23-25 have been rejected under 35 U.S.C. §103. Claims 15 and 25 have been amended. Support for the amendments to claims 15 and 25 is found on page 4, lines 31-32, and on page 6, lines 30-34, of the specification as published. Claims 1-14 have been cancelled in previous correspondence. Claims 19-22 and 26-29 have been previously withdrawn from consideration and are cancelled herein. Claims 15-18 and 23-25 remain for consideration upon entry of the present Amendment. No new matter has been added.

Claims 15-18 and 23-25 have been rejected under 35 U.S.C. §112, second paragraph, as allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter that Applicants regard as the invention. In particular, the Examiner alleges that claim 15 recites the limitation "whereby the initial fill gas contains a proportion of inert gas and carbon monoxide having a ratio based on the partial pressures thereof of at least 0.03," and that the claim is vague, indefinite, and incomplete and its metes and bounds cannot be determined because it is unclear what the term "at least 0.03" refers to.

Applicants point out that this recitation does not appear in claim 25.

Claim 15 has been amended to remove the phrase "having a ratio based on the partial pressures thereof of at least 0.03." In view of the amendment, Applicants respectfully assert that claim 15 (and claims 16-18, 23, and 24 which depend from claim 15) is definite within the meaning of 35 U.S.C. §112, second paragraph. Accordingly, Applicants respectfully request that the Examiner withdraw the rejections of the claims under 35 U.S.C. §112, second paragraph.

Because the phrase serving as a basis for the Examiner's 35 U.S.C. §112, second paragraph rejection of claim 25 is not present in claim 25, Applicants submit that the Examiner's rejection of claim 25 was in error and respectfully request that the Examiner withdraw the rejection.

Claims 15 and 23-25 have been rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 4,609,524 to Ferrari (hereinafter "Ferrari '524") in view of either one of U.S. Patent No. 4,810,461 to Inagaki et al. (hereinafter "Inagaki") or U.S. Patent No. 3,677,894 to Ferrari (hereinafter "Ferrari '894). The Examiner alleges, *inter alia*, that it

would have been obvious to one of ordinary skill in the art at the time of the invention to modify the fuel rod of Ferrari '524 by the teaching of either one of Inagaki or Ferrari '894 to have an initial fill gas pressure of at least 2 bars to gain the advantages thereof because such modification is no more than the use of a well known expedient within the nuclear art.

In one aspect of the present invention, the resistance of a nuclear fuel rod against secondary degradation is improved and secondary hydriding is prevented. Hydriding means that hydrogen is adsorbed and subsequently absorbed by the cladding material. This can lead to an embrittlement of the cladding material. Hydrogen will reach the interior of the cladding in the case of a small primary defect, which then due to hydriding can lead to a secondary defect.

To facilitate the improvement, an amount of carbon monoxide is added to the fill gas during manufacturing of the fuel rod. The carbon monoxide will remain in the fill gas and be adsorbed at positions on the surface of the zirconium material of the cladding tube, positions where hydrogen otherwise would have been adsorbed and subsequently absorbed. Consequently, the carbon monoxide will prevent absorption of hydrogen in such a way so as to prevent hydriding and degradation of the zirconium material of the cladding tube. The amount of carbon monoxide required depends upon the internal pressure in the fuel rod. In claims 15 and 25, the amount of carbon monoxide has been adapted to the internal pressure normally prevailing in a fuel rod for a boiling water nuclear reactor.

Claim 15 of the present application has been amended to recite the internal pressure (P_{fill}) of the initial fill gas in the nuclear fuel rod as amounting to at least 3 bar (abs) at room temperature (T_R) and the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas.

Ferrari '524 discloses a nuclear reactor rod having a hermetically sealed metallic tube containing a solid material and a helium atmosphere. The solid material releases tritium into the helium atmosphere. The helium atmosphere includes a minor amount (2-3 percent by volume) of oxygen, carbon monoxide, or carbon dioxide added thereto to provide for the formation of an oxide coating on the inner walls of the metallic tube to reduce the permeation of tritium through the walls of the metallic tube. The use of carbon monoxide is not specifically called out in Ferrari '524, but rather emphasis is placed on the use of carbon dioxide (in claim 2). The metallic tube may be stainless steel or a zirconium alloy, and the

solid material may be nuclear fuel pellets such as uranium dioxide or a mixed uranium-plutonium dioxide.

Ferrari '524 fails to disclose, teach, or suggest the internal pressure of the initial fill gas as amounting to at least 3 bar, as recited in claim 15. Ferrari '524 also fails to disclose, teach, or suggest the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas, as recited in claim 15.

Furthermore, the Examiner alleges on page 3 of the Office Action that although the gases in Ferrari '524 may be intended for the reduction of tritium permeation, these gases inherently also prevent hydrogenation and secondary degrading and that since the structure and method of operation in Ferrari '524 is the same as that recited in the claims, the references must each inherently function in the same manner to produce the same results as Applicant's situation.

In response, Applicants point out that the cladding tube in Ferrari '524 is metallic and has no oxide layer on the surfaces thereof. The gas of Ferrari '524 is added to the fill gas for creating an oxide layer on the inner surface of the cladding tube during operation of the fuel rod. Applicants understand that the purpose of this oxide layer is to reduce the permeation of tritium through the cladding tube. This is supported by the language of claim 1 of Ferrari '524, which explicitly states that the gas is added to form this oxide layer. The amount of gas added to the fill gas will thus not remain according to the teachings of Ferrari '524, but instead will be consumed when forming the oxide layer on the inner surface of the cladding tube. Consequently, and in contrast to the present invention as recited in claim 15, the amount of the added gas will decrease immediately after an initial use of the fuel rod.

However, even if Ferrari '524 can be said to disclose, teach, or suggest the use of carbon monoxide in the initial fill gas, it is Applicants' position that the use of carbon monoxide with regard to Ferrari '524 is inoperative. Although Ferrari '524 discloses the addition of gas to create an oxide layer, Applicants submit that it is not likely possible to form an oxide layer on a metallic surface using carbon monoxide, as recited in claim 15. The carbon monoxide will to a large extent remain in the fill gas during operation of the nuclear reactor, as confirmed by Applicants' experimentations. In Ferrari '524, however, the added gas is not intended to remain in the fill gas but is to be consumed to form the oxide layer. Thus, it would seem that carbon dioxide would be the preferred added gas according to the teachings of Ferrari '524, at least in comparison with carbon monoxide.

Inagaki discloses a zirconium-based alloy having high corrosion resistance. The alloy can be used as a material for constructing nuclear fuel cladding tubes. Inert gas is charged to the tubes at a pressure of 1 to 3 atmospheres.

Inagaki fails to disclose, teach, or suggest the internal pressure of the initial fill gas as amounting to at least 3 bar, as recited in claim 15. In Inagaki, the inert gas is charged at pressures of 1 to 3 atmospheres. Because the upper limit in Inagaki is 3 atmospheres, and because Applicants recite the internal pressure of the initial fill gas as being at least 3 bar (1 atmosphere is slightly less than 1 bar), the range recited in Applicants claim 15 is outside the range disclosed in Inagaki. Furthermore, Inagaki fails to disclose, teach, or suggest the use of carbon monoxide as an inert gas to be added to a fill gas of a nuclear fuel rod, as recited in claim 15.

Ferrari '894 discloses a fuel element that includes a plurality of fuel pellets disposed within a tubular cladding. A body of a thermally decomposable compound is disposed on the upper end of the fuel pellets. The purpose of the thermally decomposable body is to generate a gas to create an internal pressure within the fuel element. The compound may be an oxalate, which can decompose at a temperature of about 160 degrees centigrade either into iron and carbon dioxide or into a mixture of iron oxide and carbon dioxide and carbon monoxide at elevated temperatures. Helium or argon gas may be used in place of the decomposable body. The tubular cladding is designed to withstand a pressure of at least 100 pounds per square inch at 25 degrees C.

Ferrari '894 fails to disclose, teach, or suggest the internal pressure of the initial fill gas as amounting to at least 3 bar, as recited in claim 15. Ferrari '894 also fails to disclose, teach, or suggest the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas.

Furthermore, the combination of Ferrari '524 with either one of Inagaki or Ferrari '894 also fails to disclose, teach, or suggest the internal pressure of the initial fill gas as amounting to at least 3 bar and the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas, as recited in claim 15. Both Ferrari '524 and Inagaki fail to individually teach the internal pressure of the initial fill gas as amounting to at least 3 bar and the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas, as recited in claim 15. Accordingly, any combination thereof would also lack the internal pressure of the initial fill gas as amounting to at least 3 bar and the proportion of carbon

monoxide being at least 4 volume per cent of the initial fill gas, as recited in claim 15. Similarly, both Ferrari '524 and Ferrari '894 individually fail to teach the internal pressure of the initial fill gas as amounting to at least 3 bar and the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas, as recited in claim 15, and so any combination of these two references would also necessarily fail to teach the internal pressure of the initial fill gas as amounting to at least 3 bar, as recited in claim 15.

Because Ferrari '524, Inagaki, and Ferrari '894, individually and in combination, fail to disclose, teach, or suggest what Applicants claim in their amended claim 15, namely, an internal pressure (P_{fill}) of the initial fill gas in the nuclear fuel rod amounting to at least 3 bar (abs) at room temperature (T_R) and the proportion of carbon monoxide being at least 4 volume percent of the initial fill gas, Ferrari '524, Inagaki, and Ferrari '894, individually and in combination, fail to teach all of the claim recitations of Applicants' invention. Also, as previously stated, the use of carbon monoxide with regard to Ferrari '524 is inoperative, and so Ferrari '524 should be removed as a reference. Consequently, because not all of the claim recitations are taught by the cited references, and because the use of carbon monoxide as disclosed in one of the references produces an inoperative result, Applicants' amended claim 15 is necessarily non-obvious, and Applicants respectfully request that the Examiner withdraw the rejection of claim 15.

Claims that depend from a claim that is non-obvious are themselves necessarily non-obvious. Because claims 23 and 24 depend from claim 15, and because claim 15 is asserted to be non-obvious for the reasons presented above, claims 23 and 24 are necessarily non-obvious. Applicants, therefore, respectfully submit that claims 23 and 24 are allowable. Accordingly, Applicants respectfully request that the rejections of claims 23 and 24 be withdrawn.

Claim 25 has been amended to also recite that the internal pressure (P_{fill}) of the initial fill gas in the nuclear fuel rod amounts to at least 3 bar (abs) at room temperature (T_R) and the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas.

As stated above, Ferrari '524, Inagaki, and Ferrari '894, individually and in combination, fail to disclose, teach, or suggest an internal pressure (P_{fill}) of the initial fill gas in the nuclear fuel rod amounting to at least 3 bar (abs) at room temperature (T_R) and the proportion of carbon monoxide being at least 4 volume per cent of the initial fill gas, as

recited in claim 25, for the same reasons that these cited references fail to teach the recitations of claim 15.

Because Ferrari '524, Inagaki, and Ferrari '894, individually and in combination, fail to disclose, teach, or suggest what Applicants claim in their amended claim 25, namely, an internal pressure (P_{fill}) of the initial fill gas in the nuclear fuel rod amounting to at least 3 bar (abs) at room temperature (T_R) and the proportion of carbon monoxide being at least 4 volume percent of the initial fill gas, Ferrari '524, Inagaki, and Ferrari '894, individually and in combination, fail to teach all of the claim recitations of Applicants' invention. Consequently, because not all of the claim recitations are taught by the cited reference, Applicants' amended claim 25 is necessarily non-obvious, and Applicants respectfully request that the Examiner withdraw the rejection of claim 25.

Claims 16-18 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Ferrari '524 in view of either one of Inagaki or Ferrari '894 as applied to claims 15-18 and 23-25 and further in view of U.S. Patent No. 5,329,566 to King (hereinafter "King") or U.S. Patent No. 4,894,203 to Adamson (hereinafter "Adamson"). The Examiner alleges that it would have been intuitively obvious to one having ordinary skill in the art at the time of the invention to properly consider the advantages of having carbon monoxide in the fill gas of a boiling water reactor fuel rod as in Ferrari '524/Inagaki combination or in the Ferrari '524/Ferrari '894 combination against the disadvantages of having carbon monoxide in the fill gas by the teaching of either King or Adamson and that, therefore, the proportion of carbon monoxide in the initial fill gas as recited in claims 16-18 is a matter of optimization within prior art conditions or through routine experimentation. The Examiner further alleges that it would have been obvious to one of skill in the art to have determined the proper carbon monoxide/inert gas proportion such that reducing the permeability of the cladding to tritium does not adversely affect the cladding of the fuel rod.

Because claims 16-18 depend from claim 15, and because claim 15 is asserted to be non-obvious for the reasons presented above, claims 16-18 are necessarily non-obvious. Applicants, therefore, respectfully submit that claims 16-18 are allowable. Accordingly, Applicants respectfully request that the rejections of claims 16-18 be withdrawn.

Applicants believe that the foregoing amendments and remarks are fully responsive to the Office Action and that the claims herein are allowable. An early action to that effect is earnestly solicited.

If the Examiner believes that a telephone conference with Applicants' attorneys would be advantageous to the disposition of this case, the Examiner is invited to telephone the undersigned.

Applicants believe that no fees are due with the submission of this Amendment. If any charges are incurred with respect to this Amendment, they may be charged to Deposit Account No. 503342 maintained by Applicants' attorneys.

Respectfully submitted,

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